

generally, three at least of these portions being recognizable, namely, the *dental*, *angular*, and *articular*. The anterior and posterior mental spines are conspicuously developed, the line of suture of the two halves of the jaw being entirely obliterated. As in the similar palatine dentition, the enamelled coverings of the teeth are not structurally connected in the middle line.

The *zygomatic* or *jugal* bone (O), to which the lower jaw appears to be exclusively articulated, is here very fully developed. This is the *os quadratum* of birds. The anterior inferior end is hollowed out for the reception of the articular process of the jaw, the upper portion being flat and directed inwards so as partly to overlap the border of the sphenoid.

Immediately below the above are two small osseous appendages, which Bischoff regards as opercular bones. The superior one (P) is styliform, and, from its position, seems to me to represent the *symplectic* bone, hitherto supposed to be peculiar to fishes. The inferior bone (Q) is comparatively broad, and by its position appears to correspond with the pre-opercular bone of the same class. Behind, below, and in ligamentous union with these bones, the hyoid apparatus (R) is connected. It here consists simply of two large, converging, curved cylinders, slightly flattened at either end, and which, stretching forwards and downwards, unite together anteriorly in the middle line. Bischoff calls them, taken together, the tongue-bone; but it appears to me that the two divisions are homologous with the *apophyses*, or anterior cornua of the hyoid.

4. ON THE SITUATION, FORM, AND CAPACITY OF THE GALL-BLADDER IN THE VERTEBRATA; ON ITS ABSENCE IN CERTAIN ANIMALS; AND ON THE COLOUR OF THE BILE. BY EDWARDS CRISP, M.D., F.Z.S., ETC.

In 1853 I read a paper at the London Physiological Society upon the Bile and Gall-bladder, but at that period my experience was comparatively limited. A very short abstract only of this communication was published in the 'Lancet' and 'Medical Times,' 1853.

As mentioned in the charter of this Society, one of the objects of its founders was the cultivation of anatomy and physiology—departments of zoology of much greater importance, as I believe, to the good of mankind than the external characters of animals, or of their too often fanciful division into genera and species. I therefore make no apology for the introduction of the present communication, which is partly physiological.

Every circumstance connected with the secretion, quality, and quantity of the bile—a fluid of such vast importance in the animal economy—must interest the zoologist; and, as I have stated in my papers "On the Causes of Death of the Animals dying in the Society's Collection" ('Proceedings,' 1860, pp. 175, 190) that diseases of the liver, and consequently derangements of the biliary secretion, are very frequent, the investigation, I think, must be profitable to the Fellows

of the Society—especially as the subject is one that may be divested of all scientific technicality, and may readily be understood by those unacquainted with anatomy.

The first part of my communication (on the Situation, Form, and Capacity of the Gall-bladder in the Vertebrata; on its Absence in certain Animals; and on the Colour of the Bile) I make this evening; the second part (on the Structure of the Gall-bladder; the place of Entrance of the Biliary Ducts into the Alimentary Tube; the Composition of the Bile, and its Morbid Conditions) I reserve for a future occasion.

As some of my hearers are to a great extent ignorant of anatomy, I may premise that the bile, secreted by the largest gland of the body, the liver, is poured into the alimentary tube, with that of the pancreatic juice, a short distance from the pyloric end of the stomach; that it is conveyed from the liver by small tubes or ducts, which vary in number in different animals; that the gall-bladder, a membranous bag, is a reservoir for the bile, so that a due supply of this important fluid is insured when perhaps the secretory action of the liver, from causes with which we are unacquainted, is impaired. Why certain animals should be supplied with this reservoir, and why others whose structure is nearly similar, and whose food is of the same kind, should be deprived of it, are questions to be considered hereafter.

In this communication I purpose giving the result chiefly of my own dissections, and I shall not allude much to the works of others; for it is only the combination of the deductions of labourers in the same field of investigation that will enable us *hereafter* to draw positive inferences. This method is especially necessary in investigating the anatomy and physiology of the gall-bladder, as there is probably no organ in which so many deviations occur.

For the purpose of showing the form and size of the gall-bladder, I place before the Society a diagram, in which I have sketched this viscus in 306 species (so-called) of animals, including 132 mammals, 99 birds, 43 reptiles, and 32 fishes; and I also place on the table the dried and distended gall-bladders of 49 different animals. I may likewise state that I have generally taken a sketch of the gall-bladder of all the animals I have dissected, and emptied the bile upon white paper or into a bottle; so that by this means I am enabled to exhibit the bile of nearly 600 species of animals. Some of this bile has been preserved for more than twelve years. I trust that I may be pardoned for these allusions, which to some may appear to be too egotistical; but I introduce them for the purpose of showing that I have paid much attention to the subject*.

Situation of the Gall-bladder.—In the vast majority of the Vertebrata, as in the human species, this organ is placed upon the right side of the liver, and, in Mammals, more or less imbedded in its sub-

* In the present International Exhibition (Class 2, No. 503) is a frame containing the bile of nearly 600 animals, which I have cut with a gun-punch from the papers which I now exhibit, for the purpose of showing the varieties of colour of this fluid, and its utility as a pigment when properly prepared.

stance, so that often on removing the gall-bladder a portion of the liver adheres to it. In birds there is seldom a depression in the liver for its reception; but in the Chelonian reptiles it is for the most part deeply imbedded in the hepatic substance; and the same remark will apply to many of the Saurians, although I have not found it so deeply placed as in the Chelonians. In the Ophidians it is mostly far removed from the liver, and in contact with the spleen and pancreas. Thus, in a *Python* (*P. molurus*), 10 feet long, I found it 18 inches from the liver; and this will be about the proportionate distance, taking the length of the reptile into account, in most of the true serpents. In the family of Orvets (*Anguis*), only three species of which I have examined, the gall-bladder was close to the liver; and the same description will apply to the Batrachians, many foreign species of which, besides the British, I have inspected. In the British bony fishes which I have dissected, the gall-bladder has been in contact with the liver; but my list includes only about forty species. In the Tunny (*Thynnus vulgaris*) I found the body of this viscus united to the liver by a long, narrow, spiral neck; it was 14 inches in length, and about $\frac{3}{4}$ of an inch in diameter.

The Form and Capacity of the Gall-bladder.—In Man it is of a pyramidal form, and holds from one ounce to two ounces of bile. In many of the Quadrumana its form has not so great a resemblance to that of the human species as in some of the lower Mammals; thus, in six Anthropoid Apes that I have examined (three Ourangs and three Chimpanzees) the gall-bladder was of a twisted irregular shape, —a fact of importance now that some zoologists are giving these brutes, as I believe, an undue elevation in the vertebrate scale. Among the Monkeys even of the same species I have found much deviation of form in the gall-bladder: thus, in a Capuchin it was triangular, with three mamillary projections at the base, and in others nearly cylindrical. The capacity of this organ in the Quadrumana varies from one to six drachms, according to the size of the animal; probably in the old Anthropoid Apes it would be proportionately more capacious than in Man, as is the case with the smaller Monkeys, all of which consume relatively a larger quantity of food.

In the Lemurs (*Lemuridæ*), five species of which I have inspected, the gall-bladder was of a pyramidal shape, and its capacity rather large.

In the Bats (*Cheiroptera*), my notes afford no information upon the subject worthy of record.

The *Insectivora*, as far as I have examined them, have a large gall-bladder.

In the Bears (six species of which I have inspected) it is generally large and pear-shaped. In the Polar Bear (*Ursus maritimus*) I found it more irregular in form. In the Raccoon (*U. lotor*), Coatimondi (*U. nasua*), Kinkajou (*U. caudivolvulus*), Wolverine (*U. gulo*), Badger (*U. meles*), Ratel (*U. mellivorus*), and Tayra (*Mustela barbara*), it is large and pyramidal; and the same remark will apply to the Weasels, Otters, Dogs, Hyenas, and Civets. In the Cats it is often of a somewhat irregular spiral form; this is the case in the Lion and in

some of the smaller Felidæ. In a new species of *Lynx* (*F. macrocelis*) the gall-bladder was of a triangular shape, with a long narrow twisted neck; and I have seen nearly the same form in a young Lion at birth. In the Ocelot (*F. pardalis*) the neck is coiled once round; and I have found a like shape in some of the smaller Cats. In the Otter (*F. lutra*) it makes a half turn. I may remark that the form of the gall-bladder can only be properly seen when it is distended with air.

In the Seals (*Phocidæ*) (three species examined) it is of a pyriform shape, and very capacious. In the Walrus (*Trichechus*) I also found it large.

I will mention the capacity of this organ in a few of the Carnivora, in which I measured the bladder by filling it with water. The gall-bladder of the Lioness which recently died at the Society's Gardens contained five fluid ounces of bile; that of a Polar Bear (*Ursus maritimus*), four ounces; Cape Hunting Dog (*Lycan pictus*), one ounce; Clouded Tiger (*F. macrocelides*), seven drachms; Ocelot (*F. pardalis*), seven drachms. In other animals of this order its capacity, in relation to the size of the body, is about the same.

In the *Marsupialia* the gall-bladder is generally of a more rounded form than in the last-named division, and of moderate capacity. In the Tasmanian Wolf (*Thylacinus*), it held about seven drachms; in the Great Kangaroo (*Macropus major*), five drachms; in the Red Kangaroo (*M. ruber*), about the same; in the Tree Kangaroo (*Dendrolagus inustus*), about three drachms; in the *Halmaturus xanthopus*, five drachms. In the Opossums, Dasyures, and Phalangers, such as I have examined, the form and capacity, in relation to the bulk of the quadruped, is nearly the same as in the above.

In such of the Rodents as possess a gall-bladder I have generally found it of a rounded or oval form, as in the Marmot (*Arctomys alpinus*), Hare (*Lepus timidus*), Rabbit (*L. cuniculus*), Beaver (*Castor fiber*), Agouti (*Dasyprocta*), Common Mouse (*Mus musculus*), Common Squirrel (*Sciurus vulgaris*), Grey Squirrel (*S. carolinensis*), West Indian Squirrel (—?), Flying Squirrel (*S. volucella*). The capacity is moderate and tolerably uniform in the above. In the Beaver, chiefly a ligneous feeder, the capacity is about two and one-half drachms.

It was absent in the Capybara (*Hydrochaerus capybara*), in the *Sciurus maximus*, Jerboa (*Dipus*), and Musquash (*Castor zibethicus*). In other species of Rodents my attention was not directed to this subject. Cuvier states that in the genus *Mus* the gall-bladder is absent; but I think many exceptions will be found to this.

Edentata. In the Great Anteater (*Myrmecophaga jubata*) I found the gall-bladder capacious and of a somewhat pyramidal shape; in two species of Armadillo (six-banded and nine-banded) it was more cylindrical; in one of the Monotremata, the *Ornithorhynchus*, it was very large, and its form pyramidal.

The Absence of the Gall-bladder.—As far as I have gone, with the exception of the Cheiroptera, about which I am unable to speak from my own observations, as I omitted to look for this viscus in the British Bats and in many foreign species that I have dissected, all the animals I have spoken of, excepting the Rodents already mentioned

are furnished with a gall-bladder ; but we now come to a division (the Pachydermata) in which this organ is generally absent. I have found it in the Wart Hog (*Phacochoerus aethiopicus*), in Ælian's Wart-Hog (*P. alicani*), in the Red River-Hog (*Potamochoerus africanus*), in the Javan Wild Hog (*Sus vittatus*) ; but in the Wild Boar of Europe (*S. scrofa*), and in the Indian Hog (*S. indicus*) I omitted to note its presence. In the above-named animals it is long and rather capacious, containing from one and a half to two and a half ounces of bile.

It was absent in two Tapirs (*Tapirus americanus*), in the White-lipped Peccary (*Dicotyles labiatus*), and in the Collared Peccary (*D. torquatus*), in two Asiatic Elephants (*Elephas indicus*), in the Hyrax (*Hyrax capensis*) (two specimens), in the Horse (*Equus caballus*), in the Ass (*E. asinus*), and in the Zebra (*E. zebra*). I have not examined the Hippopotamus or the Rhinoceros ; but it is said to be absent in both ; so that, with the exception of the Pigs (*Suidæ*), none of the Pachyderms have a gall-bladder.

Ruminantia. This is one of the most interesting divisions as regards the physiology of the gall-bladder. It has been always stated that the solid-horned Ruminants have no gall-bladder, and that in the hollow-horned it is present—an assertion that, like too many others in zoology, has been made without sufficient evidence.

In one of the most recent articles on the Ruminantia that I am acquainted with, by Dr. Cobbold (Todd's 'Cyclopædia of Anatomy and Physiology,' 1859), this author, in reference to the gall-bladder says, "This family (the *Camelidæ*), in common with the *Cervidæ* proper, is further distinguished by the absence of a gall-bladder, whereas the hollow-horned Ruminants invariably possess this structure." In speaking of the double gall-bladder of the Giraffe, described by Professor Owen, Dr. Cobbold thinks it a circumstance serving to illustrate a feeble alliance with the *Antilopidæ* on the one hand, and a nearer approach to the *Cervidæ* and *Camelidæ* on the other.

In my dissections of the Ruminants I have sometimes omitted to sketch the gall-bladder, or to name it in my notes ; but the subjoined list of animals, I think, is sufficiently extensive to show that this supposed law is not always to be depended upon.

I found that it was absent in the Alpaca (*Lama pacos*), Lamas 2 (*L. glama*), Guanacos 2 (*L. huanaca*), Virginian Deer 2 (*Cervus virginianus*), Reindeer 4 (*C. tarandus*), Sambur Deer 2 (*C. hippelaphus*), Malacca Deer (*C. malaccensis*), Rocky-Mountain Deer (*C. —?*), Hog Deer 3 (*C. porcinus*), Brocket (*C. auritus*), Indian Deer 3 (*C. indicus*), Mexican Deer (*C. mexicanus*), and Elk (*C. alces*).

In the Wapiti Deer (*C. canadensis*), Persian Deer (*C. wallichii*), Barbary Deer (*C. barbarus*), and Barasinga Deer (*C. duvaucellii*), I did not look for it.

I found it in the Musk Deer (*M. moschiferus*), Axis Deer 3 (*C. axis*), Brocket (*C. superciliaris*) (but absent in one specimen), Leucoryx 3 (*Antilope leucoryx*), Eland (*A. oreas*), Harte Beeste (*A. caama*), Isabelline Antelope (*A. isabellina*), Striped Antelope (*A. scripta*), Dorcas Gazelle (*A. dorcas*), Indian Gazelle (*A. bezoartica*), Bennett's Gazelle (*A. bennettii*), *Gazella vera*, Spring Boc (*Antilope*

cuchore), Nylgau (*Portax pictus*) 2, also in the Mufflon (*Ovis musimon*) and Cape Sheep (*O. capensis*).

It was *absent* in three Giraffes (*Camelopardalis giraffa*) that I have examined, as well as in the following:—Duiker Boc (*Antelope mergens*), Bonte-boc (*A. pygarga*), Addax (*A. addax*), Bubaline Antelope (*A. bubalis*), Philantomba Antelope (*A. maxwellii*), Grys-boc (*A. melanotis*), Reh-boc (*A. capreola*), and Angora Goat (*Capra angorensis*); but, speaking from memory, I believe I have seen it in other specimens of the Goat.

[The figures after the names indicate the number dissected.]

The form of the gall-bladder of the Ruminants is generally somewhat pear-shaped; but the circumference of the neck is nearly equal to that of the fundus. It is generally of large proportionate size: that (of the Ox) on the table holds eleven ounces. In an old Leucoryx Antelope I found it nearly as capacious; but in two younger specimens the gall-bladders were much less. The capacity in the smaller Ruminants varies from six drachms to three ounces. The Ox, I believe, has the largest gall-bladder of any terrestrial animal—a fact of considerable interest when it is remembered that a vast number of Ruminants the food and digestive apparatus of which are of a very similar description are unprovided with this reservoir.

Birds. In the great majority of birds that I have dissected, the form is very similar: it is mostly ovoid; in some oblong; and in a few, as in the Cassowary (*Casuarus galeatus*), Cormorant (*Pelecanus carbo*), and Guan (*Penelope pileata*), nearly cylindrical. In the Double-wattled Cassowary (*Casuarus bicarunculatus*) it resembles more the gall-bladder of a mammal than that of any bird I have seen. The capacity is very uniform, and generally bears a near relation to that of the bird. As with quadrupeds, there appears to be no important difference between the animal and vegetable feeders, or in those that take a mixed diet. Its capacity is from three to four drachms in the Cranes and Storks, in the Cassowary about six drachms, in the Vultures and Eagles from two to three drachms, in the Great Bustard (*Otis tarda*) four drachms, in the Brush Turkey (*Talegalla lathamii*) three drachms.

As is well known, the Pigeons, Parrots, Mackaws, Parrakeets, Lories, Toucans, Toracos, and some other birds are said to be without a gall-bladder. I have dissected many of the above-named; but, as I took it for granted that this organ did not exist, I was not so careful in the inspections as I should have been. Cuvier says it does not exist in the Cuckoos (*Cuculidæ*); but I have found it both in the Spotted Cuckoo of Europe (*Cuculus glandarius*) and in the Java Cuckoo (*C. orientalis*). In the Ostrich (*Struthio camelus*) and in the Rhea (*Rhea americana*) I examined, it was absent, but present (as I have stated) in both species of Cassowary. The Emu I have not dissected.

Reptiles. In the Chelonian Reptiles the gall-bladder is very large. In some of the large Turtles it will contain from two to three ounces of fluid. In the Saurians it is likewise capacious. In a large Alligator, weighing about two hundredweight, its capacity was about four ounces; but in many Alligators and Crocodiles that I have in-

spected it was proportionately smaller. In the Ophidians it is of moderate size. In a Python (*Python molurus*), weighing thirty-three pounds, its capacity was about two ounces. In the Batrachians its form is more globular, and its size (relatively) larger. I have not found the gall-bladder absent in any Reptile.

Fishes. In the British Fishes (forty-two species of which I have only examined for this purpose) I found a gall-bladder, the shape globular in all, with the exception of that of the Tunny before named: it is rather capacious in this division. In a Pike (*Esox lucius*) weighing twenty-eight pounds, the capacity was about one ounce. In a Wolf-fish (*Anarrhichas*) weighing twelve pounds, about the same. In the *Lophius piscatorius*, a very ravenous fish, it was much smaller. In the Shark (*Lamna cornubica*), Dog Fishes (*Scyllia*), and Rays (*Raiadæ*) its proportionate capacity is about the same as in the osseous fishes.

Before I finish this part of my subject, I will add a few remarks about the supposed absence of a gall-bladder in many fishes. Cuvier did not depend always upon his own observations. I believe that this organ has escaped notice in many instances, especially in the Fishes. The Giraffe was supposed not to possess a gall-bladder; but in two examined by Professor Owen, one was without a gall-bladder, the other had a double gall-bladder, as may be seen in the preparation in the Hunterian Museum.

As I have stated before, in three Giraffes that I have inspected, this viscus was wanting in all. I have met with one specimen of a double gall-bladder in the Sheep; and in the Hunterian Museum there is the liver of a small animal (unknown) with three distinct gall-bladders; so that I think it will be well for future observers not to assume that this reservoir is absent, but to look for it in all the Vertebrata. It is well to remember, too, that the gall-bladder in some reptiles and fishes is not always close to the liver—a circumstance, as stated by Cuvier, that may have led to its having been often undiscovered. Sir E. Home, as mentioned in the 'Museum Catalogue of the College of Surgeons,' described, in the 'Philosophical Transactions' for 1809, the Basking Shark (*Selache maxima*) as being without a gall-bladder. M. de Blainville (in the 'Annales du Muséum,' 1811) found a gall-bladder in this fish, 4 or 5 inches in diameter; but it was seated 6 feet from the liver. As I am speaking of the Hunterian Museum, I may add, for the purpose of showing how little this subject has been attended to, that only ten gall-bladders are to be seen in this collection—one of a Fish, three of Reptiles, three of Birds, and three of Quadrupeds.

I have only time for a passing remark on the quantity of bile secreted by various animals. The estimate must to a great extent be conjectural; but in the human subject, where fistulous communications have been accidentally established, and in Dogs and other animals where the ducts have been exposed, some indications of the average daily quantity of this secretion may be formed. Thus, in Man it is probably from six to ten ounces daily. In the domesticated Ox—a quadruped (as before stated) that has, I believe, a larger

gall-bladder than any land animal—from thirty to sixty ounces; by some physiologists a much larger quantity is given. The daily amount of bile secreted depends probably upon the quantity and quality of the food. Thus, animals that eat frequently have most likely a larger secretion; whilst those that fast for a long period (as some of the reptiles), although they possess large gall-bladders, have comparatively a small secretion of bile. There appears to be no important difference between the animal and vegetable feeders; nor does the absence of a gall-bladder, as far as we can ascertain, influence the quantity of the secretion.

The Colour of the Bile.—The specimens before the Society, from all divisions of the Vertebrata, show the great variety of colours exhibited by this fluid: all shades of brown, green, and yellow are present, and many of them very vivid and intense. It must be observed that animals in confinement often have the bile in an abnormal condition; and probably the colour is influenced to a great extent by the diseased or healthy condition of the liver—a matter to be spoken of hereafter.

In fishes the colour is generally of a light yellow, in some inclining to brown. In reptiles some of the most vivid browns, yellows, and greens are seen: the last-named colour is not unfrequent in the web-footed birds and in some of the Rapaces; but the prevailing colours in the birds are browns and yellows. In mammals the intense greens are rarely seen; but the colours vary from light green to shades of yellow or brown of every hue. The applicability of this fluid as a pigment cannot be properly touched upon here.

In this paper I have spoken entirely from my own observations, and I have handled the matter in a different manner to that of any previous inquirer; so that zoologists who may hereafter investigate this interesting subject may, by combining my labours with those of others in the same field of research, profit, I hope, by this investigation.

Mr. A. Murray pointed out the characters of a new Crocodile from the Old Calabar River, West Africa, for which he proposed the name *Crocodylus frontatus*, as indicative of the large size of the forehead in this species.

The following lists of the additions to the Menagerie during the months of January, February, and March were laid before the meeting:—

JANUARY.

		Presented by
1 Common Teuch.....	<i>Tinca vulgaris</i>	C.D. Tanqueray Willaume, Esq.
1 Red and Yellow Maccaw.....	<i>Ara ararauna</i>	Mr. Atcheler.
1 Bonnet Monkey.....	<i>Macacus radiatus</i>	R. Ridgley, Esq.
1 Chamelion	<i>Chamæleo vulgaris</i>	Dr. Babington.
1 Pig-tailed Monkey.....	<i>Macacus nemestrinus</i>	E. Walden, Esq.
1 Maltese Pig	<i>Sus scrofa</i> , var.....	J. Cunningham, Esq.
1 Crested Curassow	<i>Craz alector</i>	Dr. Kelaart of Trinidad.
2 Common Ravens	<i>Corvus corax</i>	Rev. W. Willimott.